Chapter 12
Transdisciplinarity, Human-Nature Entanglements, and Transboundary Water Systems in the Anthropocene

Jason M. Kelly

This essay introduces some major ideas and concepts relating to transdisciplinary approaches to Anthropocene river systems. The first section is a historical case study of George Catlin, an artist who traveled throughout the Great Plains in the 1830s. Catlin's writing embodies popular 19th-century ideas about "pristine" natural states which have continued to shape environmental thought into the 21st century. By exploring Catlin's descriptions of the Hidatsa, a community at the confluence of the Knife and Missouri Rivers, it shows the importance of integrating human-nature entanglements into studies of anthropogenic environmental change. Key to understanding these changes are cultural and socio-political structures that shape and are shaped by the environment.

The second part of this essay uses the example of the Cochabamba *Guerra del Agua* in 2000 to examine human-nature entanglements in transboundary water systems. Specifically, it considers the ways that human systems at multiple scales define boundaries, shape policy, and transform environments. Rather than simply focus on transboundary water systems as physical presences, it argues for the importance of expanding the definition of "transboundary" to include non-physical systems, including sociocultural structures and practices.

The two case studies are not meant to be exhaustive. Rather, they are surveys meant to exemplify the complex intersections of cultural, economic, and political interests around water resources in the Americas. They demonstrate current scholarly thinking related to human-nature entanglements and transboundary water systems. For more information on each of the case studies, the reader is directed to the bibliography.

Rivers and their ecologies are not simply natural systems; they are human systems as well. They shape human societies even as they are shaped by them. In fact, separating human and environmental systems is an artificial division which is

J. M. Kelly (✉)
IUPUI Arts and Humanities Institute and Department of History in the IU School of Liberal Arts at IUPI, Indiana University-Purdue University, Indiana, Indianapolis
e-mail: jaskelly@iupui.edu

A. Bhaduri et al. (eds.), *The Global Water System in the Anthropocene*,
Springer Water, DOI: 10.1007/978-3-319-07548-8_12,

a product of historically constituted epistemological categories. (Castree and Braun 2005; Cronon 1996) Riverine ecologies emerge from a series of complex interactions between the atmosphere, hydrosphere, lithosphere, and biosphere. In the age of the Anthropocene, these biophysical systems have been dramatically affected by one species: humans. As a result, the study of anthropogenic biophysical processes has become a key area of focus for scientific research. However, the majority of studies focus on the consequences of human action, not on the systems driving human actions. In other words, researchers are increasingly gathering information about the effects of human-induced environmental change, but they are at the earliest stages of linking effects to causes.

Understanding the causes of anthropogenic environmental change requires the techniques developed in the social sciences and humanities. Anthropogenic changes result from patterns of human behavior, which are shaped and reshaped by sociocultural systems. For example, cultural beliefs can limit responses to ecological crises and therefore contribute to environmental feedback loops.

A complex network of disparate systems and objects are linked at the human-riverine interface, connected by a chain of historical material and sociocultural structures. This interrelation is what we might call an entanglement. (Hodder 2011, 2012; Latour 2005; Malafouris and Renfrew 2010; Demarrais et al. 2004) In the Anthropocene, when humans have had an increasingly powerful effect on global riverine environments, these entanglements are ever more apparent. As Matt Edgeworth has recently argued, "If the river ever was entirely a natural entity, it has long since been at least partially honed to fit human projects. If it ever was wholly wild and untamed, it has long since been at least partially domesticated. And if it ever was merely an environmental entity, it has long since become part of the cultural landscape" (Edgeworth 2011, 14).

Transdisciplinary approaches, which connect the strengths of the sciences, social sciences, and humanities, are more likely to result in a comprehensive understanding and sustainable solutions to human-induced environmental change, because they can better understand the entanglements of environmental systems and human systems. This perspective has been articulated by several research groups including IHOPE, the Integrated History and Future of People on Earth which is a project of the International Geosphere and Biosphere Programme (IGBP), and UNESCO's International Hydrological Program (Costanza et al. 2007, 2012; Davies and M'Mbogori 2013; Hassan 2011; Hibbard et al. 2010; Hornborg and Crumley 2006; Mosley 2006; Sörlin 2012). In 2012, the European Science Foundation, Strasbourg and European Cooperation in Science and Technology, Brussels commissioned a report, titled *RESCUE*, which argued for more conceptual and methodological disciplinary integration (Jäger et al. 2012). *RESCUE* argued that the social sciences and humanities have been auxiliary to scientific environmental research—despite long decades of work in the environmental social sciences and humanities. And, while some social science research, including human population patterns, economies, and governance frameworks, has been integrated into scientific research, valuable insight from ethnography, social and cultural history, environmental ethics, and postcolonial literary criticism has

remained peripheral. Bridging this divide will require projects that address the "two culture" problem directly, a task targeted by such collaborations as the Rivers of the Anthropocene project (rivers.iupui.edu).

In 1830, George Catlin, a Pennsylvania-born artist, arrived in St. Louis looking for fame and fortune. There, he sought the patronage of General William Clark, the U.S. Superintendant of Indian Affairs. A connection to General Clark was no mean feat. Clark was the famed explorer who—with Meriwether Lewis, Sacagawea and the "Corps of Discovery"—made a three-year transcontinental trek to the Pacific Ocean in 1804. In addition to connecting Catlin to networks of other patrons, Clark eventually helped him gain passage aboard the steamship *Yellow Stone* in 1832 (Dippie 1990). The voyage was meant to prove the "practicability of steam navigation" on the Missouri River, and it traveled as far north as Fort Union, 2,000 miles upriver from St. Louis (Buckingham and Buckingham 1832). Its success hastened the expansion of U.S. economic and imperial endeavors into the upper portions of the Louisiana Purchase. For his part on the voyage, Catlin took the opportunity to record ethnographic observations, topographical landscapes, and portraits of the indigenous peoples whom he encountered, eventually translating them into a series of books. Often capturing the mood of his contemporaries—philosophers, artists, and scientists alike—his publications saw the peoples and places of the American West through a lens of romantic sentimentality:

> And what a splendid contemplation too, when one (who has travelled these realms, and can duly appreciate them) imagines them as the *might* in the future be seen (by some great protecting policy of government) preserved in their pristine beauty and wildness, in a *magnificent park*, where the world could see for ages to come, the native Indian in his classic attire, galloping his wild horse, with sinewy bow, and shield and lance, amid the fleeting herds of elks and buffaloes. (Catlin 1850).

His descriptions are visions of unspoiled nature, which in its wildness was beautiful and worthy of preservation. In many ways, Catlin was a product of his time, but his statements demonstrate ideas that remain central to the construction of environmental discourse into the 21st century. (Anderson 2002).

In discussing the environment, Catlin followed the classical European distinction between the human and the natural worlds, which became increasingly important in the writings of seventeenth and eighteenth-century natural philosophers. "Nature" was that realm which existed beyond the artifice and invention of human societies. To Catlin and his contemporaries, nature could exist in a pure state. Untouched by humans, it could be "pristine". The value of preserving and protecting pristine nature was an important philosophical stance among 19th-century Romantics, who recoiled from the excesses of urbanization and industrialization. A corollary to this notion of the purity of untouched nature was the idea that some humans—groups designated by the Europeans as innocent, unchanging, and uncorrupted by society, such as the Tahitians and James Fenimore Cooper's Mohicans—could live harmoniously in a state of nature. As with the pristine state of flora and fauna, writers such as Cooper and Catlin, argued that "natural man"

was similarly threatened by imperialism, Indian removal policies, and assimilation. Catlin went so far as to muse about a "*magnificent park*," which would bound and protect them.

This bifurcated approach to nature, in which humans either lived outside of it or in harmony with it, simplified the complex historical relations that humans have with their environments. Catlin was just one of many who ignored evidence of the substantial human-induced ecological impacts—even those by non-urbanized and unindustrialized communities. For example, Catlin's description of the Missouri River, the riparian ecology, and the prairie was one of nature in balance, full of rich alluvial soils and dotted with "luxuriant forest timber" (Catlin 1850). Settlements, such as those of the Hidatsa at the confluence of the Knife River and Missouri River, were communities in physical and spiritual balance with their surroundings.

Below this veneer however were the centuries-long processes of anthropogenic biophysical forces. The Hidatsa, for example, were one of many groups which practiced swidden agriculture, burning tracts of land to clear their fields. They also used controlled fires to burn grasses which would attract buffalo to new growth (Anderson 2002; Courtwright 2011). The "natural" grasslands were, in fact, environments created by humans. The change in flora altered the fauna as well. Archaeological evidence suggests that there was an influx of Deer Mice (Peromyscus) into the Hidatsa settlements after the 17th century. Part of this is attributable to climate change, but Hidatsa land use and grain storage also played a significant role (Ahler et al. 1993). As a "fire positive" species—meaning that it thrives in fire-prone ecologies—the Deer Mouse population was aided by human induced prairie fires (Kaufman and Kaufman 1997).

The Hidatsa leaders explained to Catlin that the Deer Mice were out of control by the 1820s, destroying their clothes and infesting their stores. However, the arrival of a new species—likely the long-tailed weasel—to the Hidatsa villages introduced a new predator into the local ecology. According to Catlin, the leaders saw no need to control the weasels, which quickly reduced the Deer Mouse population, as it seemed a blessing from the "Great Spirit." However, since the weasel thrived in riverine environments, their numbers skyrocketed. The Hidatsa soon found the food in their *caches*, or storage cellars, eaten. The floors of their houses even began collapsing from the burrows. (Catlin 1850) According to an official from the American Fur Company, their traders had been responsible for the introducing the weasels when the animals had escaped the company's keel boats.

The example of the Knife River Hidatsa community demonstrates the ways that human systems and natural systems are entangled. The prairie itself was maintained over millennia by indigenous peoples who used fire to shape their ecologies (Abrams and Nowacki 2008). The alluvial soils at the river confluence made the location an ideal one for agriculture, encouraging human settlement. And, a combination of changing climate and human land use patterns reshaped the fauna. With the arrival of Europeans with interests in fur trading and imperial expansion, the river became a central artery for ecological exchange.

The choice of the Hidatsa for their settlement and their continued mix of sedentary agriculture and hunting patterns were not simply environmentally predetermined either; they were the result of sociopolitical forces at the regional and international levels. The Knife River confluence put them at the center of a vast trading network in which they had become important agricultural exporters and traders by the mid eighteenth-century. Their emphasis on agriculture meant that they remained sedentary even as other groups in the Plains region became nomadic due to the social transformations effected by horses and guns. The expansion of European and American empires and the instability caused by Old World technologies, fauna, and disease not only reduced their population, but stifled their expansion and movement. Likewise, competition for the control of European trade, with groups such as the American Fur Company and Hudson's Bay Company, heightened rivalries among regional groups. By the 1830s, the Hidatsa were hemmed in on the west and south by the Lakota (Calloway 1982; Hanson 1986; Martin and Szuter 1999). But, their position on the Missouri River system meant that the American Fur Company established an important post nearby (Wishart 1992). And, with the trade came the potential for invasive species, such as the weasel.

Catlin's writing represents how powerful the trope of "pristine" natural states was in nineteenth-century—a trope that continues to permeate popular environmental discourse in the 21st century. Catlin argued for the preservation of a "natural" state even as his descriptions revealed significant anthropogenic effects on the Missouri and Knife River ecologies. And, in fact, these ecologies were part of a broader, international network of human activities that ranged across cultures and continents. Competition between rival groups—the Lakota, the British, the Hidatsa, and the Americans—for control of territory and trade meant that this section of the Missouri River would both shape their activities and in turn be reshaped by them.

Examining rivers as human-nature entanglements necessitates that we see them as complex, dynamic structures that include both material and non-material systems. In effect, they are geomorphological, biophysical, *and* sociocultural systems. This observation has implications that go to the heart of research questions and methodologies as well as environmental policy. Examining a river as a natural system means studying it as a complex ecology of interdependent non-living and living components. A river is not simply determined by flows, drainage systems, or basins; it is also a biological entity that is deeply entwined with regional flora and fauna, including humans. As part of this riverine ecology, humans make multiple demands on it. These demands emerge from technological, economic, social, or cultural needs and include sanitation, flood control, transportation, recreational space, sacred space, aquaculture, and wastewater runoff channels. As humans use rivers, they impose sociocultural frameworks on river systems, which include political, scientific, religious, economic, and ideological components. These sociocultural frameworks help determine human activities and can facilitate or limit actions, and consequently are key to understanding rivers as human-nature entanglements.

Take for example the notion of a transboundary water system. A transboundary system denotes a geomorphological structure that cuts across boundaries—typically those of a nation-state. However, in the age of the Anthropocene, a host of environmental factors, including non-point pollution and climate change, mean that even water basins bounded within a single nation-state can be affected directly by extraterritorial policies and actions. Furthermore, sociocultural frameworks can have both local and transnational aspects. For example, geopolitical agendas in one part of the world might determine (or at least direct) the water policies of a nation in another part of the world. Because of this, it is useful to designate two forms of transboundary water systems: contiguous and non-contiguous. A contiguous transboundary water system is one shared by two contiguous states. An example would be the Colorado River, which is shared by the United States of America and Mexico. A non-contiguous transboundary water system is one which is physically bounded within a state but which is embedded in a transnational sociocultural system. An example would be the Yangtze River in China, which is at the center of international debates over the environmental, human, and cultural consequences of damming rivers (Lee 2013).

Bolivia's *Guerro del Agua* of 2000 highlights a number of ways in which transnational sociocultural systems are entwined with local water systems and are central to understanding both human-nature entanglements and addressing policy issues. In 2000, Cochabamba, Bolivia was a city of approximately 500,000 people and growing. Situated in a valley in the Andes, it was the 3rd largest city in the country. As an industrial hub and center for migration, its recent history had been one of continuous demographic growth. However, the city's infrastructure did not keep pace with growth, leading to unequal access to public resources such as water. And, despite the fact that the name Cochabamba is derived from "Kucha Pampa"—the Quechua word for swampland—deforestation, drought, and an overburdened water table meant that water was a precious commodity. (Shultz 2008).

To obtain water, residents relied primarily on three means. About 50 % of the residents were supplied by the Servicio Municipal de Agua Potable y Alcantarillado (SEMAPA), which administered the public reservoirs, wells, and sanitation system. SEMAPA's system provided better service to wealthier districts, which left poorer neighborhoods to rely on water delivery trucks and rain barrels. Outside of the urban core, many residents obtained water from cooperative wells and water delivery systems. Farmers had even challenged SEMAPA over where it drilled wells because it lowered the water table and threatened their access to freshwater. In 1997, they organized the Federación Departamental Cochabambina de Regantes (FEDECOR), which aimed to protect customary and communal water rights—*usos y costumbres*. (Perreault 2008) In effect, Cochabamba was an amalgam of local water management regimes, which would soon be caught up in transnational economic policies.

In the 1980s, Bolivia's national debt and inflation—the product of military rule, financial mismanagement, and subsequent instability—led the Bolivian government to pursue a regime of neoliberal economic reforms, including the

privatization of the national infrastructure (Kohl 2006). Set into motion by the Decreto Supremo 21060[1], the policies helped the Bolivian government delay loan repayments and guarantee new loans from the IMF and the World Bank. A letter of intent to the IMF in 1998 promised to privatize "all remaining public enterprises" (Müller and Morales 1998). The following year, the World Bank explicitly targeted the public water system in Cochabamba, noting that it should be privatized. As part of the restructuring, water fees would go up to pay for building the Misicuni Multipurpose Project, which was meant to provide electricity and freshwater through damming the Misicuni River. The World Bank report stated that no public subsidies should be used "to ameliorate the increase in water tariffs in Cochabamba. (World Bank 1999).

Compliance with the World Bank recommendations promised economic aid for the government. Within months the Bolivian government granted a single-bid contract to Aguas del Tunari, which was owned by the Bechtel Corporation subsidiary International Water Limited as well as several Bolivian companies with links to the Bolivian government. (Nickson and Vargas 2002 fn 10). The deal gave Aguas del Tunari a 40 year contract to run the water system with a promise of an average 16 % annual return on investment. These conditions meant that the average consumer saw an increase of 35 % in their water bills, but some saw increases as high as 300 %. For many of the poorest, these increases were nearly impossible to pay. Meanwhile the government passed legislation—(Ley 2029[2]: Ley de Servicios de Agua Potable y Alcantarillado Sanitario)—which commercialized the water supply and threatened the *usos y costumbres* of local cooperatives. (Assies 2003).

The reaction to these moves was quick and potent. Roads were blockaded by FEDECOR in protest, and this was soon followed by an alliance with the Federación de Trabajadores Fabriles de Cochabamba—an engagement that led to the creation of the Coordinadora de Defensa del Agua y de la Vida. Confrontations with the government centered on several concerns: the cost of water, the *usos y costumbres*, and anti-neoliberal sentiment. Government repression and violence was met with mass protest and resistance, eventually leading the government to end the contract with Aguas del Tunari and integrating the Coordinadora de Defensa del Agua y de la Vida into the management of SEMAPA.

Understanding the water war in Cochabamba requires an understanding of both the local environmental conditions as well as the transnational sociocultural frameworks in which it exists. While representatives on all sides were aware of the need for addressing the water supply issue, ideological positions helped determine solutions. There were three primary ideological frameworks for addressing the water system in Cochabamba: neoliberal market mechanisms, social democracy,

[1] Decreto Supremo 21060, 29 August 1985. http://www.gacetaoficialdebolivia.gob.bo/normas/buscar/21060. Accessed July 11, 2014.

[2] Ley 2029, 29 October 1999. http://www.lexivox.org/norms/BO-L-2029.xhtml. Accessed July 11, 2014.

and the moral economy of the *usos y costumbres*. Each was concerned, in its own way, with ameliorating the problems facing the city's residents—from poor sanitation to the absolute scarcity of water. The World Bank in alliance with the government, sought to address the problem by imposing an economic model that they imagined would boost economic growth through the market economy. Social democrats rejected privatization out-of-hand, preferring a state-based solution that would answer to the people. Those arguing for the *usos y costumbres* preferred a locally based program tied to community needs. Consequently, the local material conditions, which had been created by environmental and anthropogenic processes, were tied to transnational ideological debates, power struggles, and global economics. As such, the water system in Cochabamba was an transnational entanglement of environmental, social, political, technological, and cultural expectations and practices.

The short case studies described above only hint at the complex sociocultural-environmental entanglements that are central to the Cochabamba and the Missouri water systems. Only a transdisciplinary analysis of these entanglements—one that blends scientific knowledge of earth systems with social scientific and humanistic knowledge of human systems—is likely to get at the complex material and non-material interrelations and feedback mechanisms inherent to the system. This means that new transdisciplinary conceptual and methodological frameworks are necessary for studying anthropocene environments and developing policies to mitigate anthropogenic environmental impacts. New approaches will need to pay close attention to the role of human agency and the construction of sociocultural systems at multiple scales in order to understand the mechanisms by which sociocultural systems converge with environmental systems. Doing so will allow scholars to understand not only the effects of anthropogenic environmental change, but the processes that drive human behavior and action.

References

Abrams MD, Nowacki GJ (2008) Native Americans as active and passive promoters of mast and fruit trees in the eastern USA. Holocene 18(7):1123–1137

Ahler SA, Snyder LM, Falk CR, Semken HA Jr (1993) KNRI and Upper Knife-Heart Region unmodified faunal remains. In: The phase I archeological research program for the Knife River Indian Villages National Historic Site. U.S. Department of the Interior, National Park Service, Midwest Archeological Center 263–272

Anderson MK (2002) An ecological critique. In: Stewart OC (ed) Forgotten fires: Native Americans and the transient wilderness. University of Oklahoma Press, Oklahoma City, pp 37–64

Assies W (2003) David versus Goliath in Cochabamba: water rights, neoliberalism, and the revival of social protest in Bolivia. Latin Am Perspec 30(3):14–36

Castree N, Braun B (eds) (2005) Social nature: theory, practice, and politics. Blackwell, Malden

Buckingham JT, Buckingham E (eds) (1832) Trade in the West. In: The New England Magazine 3:262

Calloway CG (1982) The inter-tribal balance of power on the Great Plains, 1760-1850. J Am Stud 16(1):25–47

Catlin G (1850) Illustrations of the manners, customs, and condition of the North American Indians. 9th edn. vol. 1. Henry G. Bohn, London
Courtwright J (2011) Prairie fire: a great plains history. University Press of Kansas, Lawrence
Cronon W (1996) Uncommon ground: rethinking the human place in nature. W. W. Norton & Company, New York
Costanza R et al (2012) Developing an integrated history and future of people on Earth (IHOPE). Curr Opin Environ Sustain 4(1):106–114
Costanza R, Graumlich L, Steffen W (eds) (2007) Sustainability or collapse?: an integrated history and future of people on Earth. The MIT Press, Cambridge
Davies MIJ, M'Mbogori FN (eds) (2013) Humans and the environment: new archaeological perspectives for the twenty-first century. Oxford University Press, Oxford
DeMarrais E, Gosden C, Renfrew C (eds) (2004) Rethinking materiality: the engagement of mind with the material world. McDonald Institute for Archaeological Research. Oxbow Books and David Brown, Cambridge
Dippie BW (1990) Catlin and his contemporaries: the politics of patronage. University of Nebraska Press, Lincoln
Edgeworth M (2011) Fluid pasts: archaeology of flow. Bristol Classical, Bristol
Hanson JR (1986) Adjustment and adaptation on the northern plains: the case of equestrianism among the Hidatsa. Plains Anthropologist 31(112):93–107
Hassan F (2011) Water history for our times, IHP essays on water history, vol 2. UNESCO, Paris
Hibbard KA et al (2010) Developing an Integrated History and Future of People on Earth (IHOPE): Research Plan. IGBP Secretariat. http://www.uvm.edu/giee/pubpdfs/Costanza_2012_Current_Opinion_in_Environmental_Sustainability.pdf. Accessed August 15, 2013
Hodder I (2011) Human-thing entanglement: towards an integrated archaeological perspective. J Roy Anthropol Inst 17(1):154–177
Hodder I (2012) Entangled: an archaeology of the relationships between humans and things. Wiley, London
Hornborg A, Crumley CL (eds) (2006) The world system and the Earth system: global socioenvironmental change and sustainability since the Neolithic. Left Coast Press, Walnut Creek
Jäger J et al (2012) Responses to environmental and societal challenges for our unstable earth (RESCUE), ESF Forward Look—ESF-COST "Frontier of Science" Joint Initiative. European Science Foundation, Strasbourg and European Cooperation in Science and Technology, Brussels. http://www.esf.org/fileadmin/Public_documents/Publications/rescue.pdf. Accessed August 15, 2013
Kaufman GA, Kaufman DW (1997) Ecology of small mammals in prairie landscapes. In: Knopf FL, Samson FB (eds) Ecology and conservation of great plains Vertebrates. pp 207–43. Springer, New York
Kohl B (2006) Challenges to neoliberal hegemony in Bolivia. Antipode 38(2):304–326
Latour B (2005) Reassembling the social: an introduction to actor-network-theory. Oxford University Press, Oxford
Lee YB (2013) Global capital, national development and transnational environmental activism: conflict and the Three Gorges Dam. Journal of Contemporary Asia 43(1):102–126
Malafouris L, Renfrew C (2010) The cognitive life of things: archaeology, material engagement and the extended mind. In: Malafouris L, Renfrew C (eds) The cognitive life of things: recasting the boundaries of the mind. McDonald Institute for Archaeological Research and Oxbow Books, Cambridge, pp 1–12
Martin PS, Szuter CR (1999) War zones and game sinks in Lewis and Clark's West. Conserv Biol 13(1):36–45
Mosley S (2006) Common ground: integrating social and environmental history. J Soc Hist 39(3):915–933
Müller H, Morales, JA (1998) Bolivian letter of intent to the IMF for economic reforms. http://www.imf.org/external/np/loi/081498.HTM. Accessed October 4, 2013
Nickson A, Vargas C (2002) The limitations of water regulation: the failure of the Cochabamba concession in Bolivia. Bull Latin Am Res 21(1):99–120

Perreault T (2008) Custom and contradiction: rural water governance and the politics of usos y costumbres in Bolivia's irrigators' movement. Ann Assoc Am Geogr 98(4):834–854
Shultz J (2008) The Cochabamba water revolt and its aftermath. In: Draper M, ShultzJ (eds) Dignity and defiance: stories from Bolivia's challenge to globalization. University of California Press, Berkeley, pp 9–42
Sörlin S (2012) Environmental humanities: why should biologists interested in the environment take the humanities seriously? Bioscience 62(9):788–789
Wishart DJ (1992) The fur trade of the American West: 1807–1840: a geographical synthesis. University of Nebraska Press, Lincoln
World Bank (1999) Bolivia Public Expenditure Review. Report number 19232-BO